What is claimed is:

1. A therapeutic radiation source, comprising:

A. a probe assembly including an optical delivery structure having a proximal end and a distal end, said optical delivery structure being adapted for transmitting optical radiation incident on said proximal end to said distal end;

B. an optical source, including means for generating a beam of optical radiation directed to said proximal end of said optical delivery structure;

C. a radiation generator assembly coupled to the probe assembly, including:

   a. an electron source, responsive to light transmitted to said distal end of said optical delivery structure, for emitting electrons; and

   b. a target element including at least one radiation emissive material adapted to emit therapeutic radiation in response to incident electrons from said electron beam;

D. means for providing an accelerating voltage between said electron source and said target element so as to establish an accelerating electric field which acts to accelerate electrons emitted from said electron source toward said target element; and

E. an in situ radiation detecting system for monitoring an amount of the therapeutic radiation emitted by said target element, said radiation detecting system including:

   a. a scintillator disposed along a path of the therapeutic radiation emitted by said target element and adapted to generate scintillator light in response to the therapeutic radiation incident thereon, wherein the intensity of said scintillator light is proportional to the intensity of said incident therapeutic radiation;

   b. a photodetector in optical communication with said scintillator for converting said

scintillator light into a signal indicative of the intensity of said incident therapeutic radiation.

2. A therapeutic radiation source according to claim 1, further including a feedback controller responsive to said indicative signal, the feedback controller including:

a. a controller including processing means for calculating a cumulative dosage of said therapeutic radiation, and control means for controlling the intensity and duration of the emitted therapeutic radiation; and

b. a feedback circuit for feeding back said indicative signal to the controller.

3. A therapeutic radiation source according to claim 1, wherein said feedback controller includes a display unit, so as to allow real time visual monitoring of the therapeutic radiation emitted by said target element and delivered to a treatment region.

4. A therapeutic radiation source according to claim 1, wherein said therapeutic radiation includes x-rays.

5. A therapeutic radiation source according to claim 1, wherein said optical source is a laser source, and wherein said beam of optical radiation is substantially monochromatic and coherent.

6. A therapeutic radiation source according to claim 1, wherein said laser source is selected from the group consisting of a diode laser, a molecular laser and a solid state laser.

7. A therapeutic radiation source according to claim 1, wherein said scintillator is affixed to said distal end of said fiber optic cable.

8. A therapeutic radiation source according to claim 1, wherein said radiation detection system further includes an optical system for selectively directing light so that only said scintillator light is incident upon said photodetector, the optical system being adapted for separating said scintillator light from ambient visible light and from optical radiation generated by said optical source.

9. A therapeutic radiation source according to claim 8, wherein said optical system comprises a dichroic beam splitter and a filter, each being disposed between said optical source and said fiber optical element.

10. A therapeutic radiation source according to claim 1, wherein said optical delivery structure is a fiber optic cable.

11. A therapeutic radiation source according to claim 1, wherein said probe assembly comprises an electrically conductive, flexible, outer sheath enclosing said optical delivery structure.

12. A therapeutic radiation source according to claim 1, wherein said photodetector comprises a photomultiplier tube.

13. A therapeutic radiation source according to claim 1, wherein said electrons incident on said target element from said electron source are accelerated by said electric field to energies in the approximate range of 10 keV to 90 keV.

14. A therapeutic radiation source according to claim 1, wherein the emitted electrons form an electron beam along a beam path, and wherein said target assembly is positioned in said beam path.

15. A therapeutic radiation source according to claim 14, wherein said electron beam is characterized by a current in the approximate range of 1 nA to 100 μA.

16. A therapeutic radiation source according to claim 2,

wherein said control means comprises intensity control circuitry for controlling the intensity of the emitted therapeutic radiation, and duration control circuitry for controlling the duration of the emitted therapeutic radiation; and

further wherein said intensity control circuitry comprises programmable means for user-controlled adjustment of at least one of the magnitude of said accelerating voltage and the magnitude of the current formed by said electron beam.

17. A therapeutic radiation source according to claim 16, wherein said duration control circuitry comprises means for selectively activating said optical source.

18. A therapeutic radiation source according to claim 16, wherein said duration control circuitry comprises means for selectively activating said means for providing an accelerating voltage.

19. A therapeutic radiation source according to claim 1, wherein said scintillator is made of a crystalline material.

20. A therapeutic radiation source according to claim 19, wherein said crystalline material is selected from the group consisting of sodium-iodide, cesium-iodide, bismuth-germanate, cesium-fluoride, ZnS, YAP:Ce (yittrium aluminum perovskite), terbium doped glass fiber.

21. A therapeutic radiation source according to claim 1, wherein said scintillator is made of a material selected from the group consisting of glass, terbium doped glass fiber, and polymers.

22. A therapeutic radiation source according to claim 1, wherein said electron source includes a photocathode having a photoemissive surface, said photocathode being positioned adjacent to said distal end of said optical delivery structure and being responsive to portions of said beam of optical radiation incident thereon from said distal end of said optical delivery structure to emit electrons from said photoemissive surface.

23. A therapeutic radiation source according to claim 1, wherein said electron source includes a thermionic cathode having an electron-emissive surface and adapted to emit electrons when heated to a sufficient temperature by a laser beam

24. A therapeutic radiation source, comprising:

A. a probe assembly including an optical delivery structure, said optical delivery structure having a proximal end and a distal end, and adapted for transmitting optical radiation incident on said proximal end to said distal end;

B. an optical source, including means for generating a beam of optical radiation directed to said proximal end of said optical delivery structure;

C. a radiation generator assembly coupled to said distal end of said optical delivery structure, the radiation generator assembly including:

a. an electron source, responsive to optical radiation transmitted to said distal end of said optical delivery structure, for emitting electrons to generate an electron beam along a beam path, the electron source including a thermionic cathode having an electron emissive surface; and

b. a target element positioned in said beam path and spaced apart and opposite said electron emissive surface of said thermionic cathode, said target element including at least one radiation emissive material adapted to emit therapeutic radiation in response to incident accelerated electrons from said electron source;

wherein said optical delivery structure is adapted for directing a beam of said transmitted optical radiation to impinge upon said electron emissive surface of said thermionic cathode, said beam of optical radiation having a power level sufficient to heat at least a portion of said surface to an electron emitting temperature so as to cause thermionic emission of electrons from said surface;

D. means for providing an accelerating voltage between said electron source and said target element so as to establish an accelerating electric field which acts to accelerate electrons emitted from said electron source toward said target element;

and

E. an in situ radiation detecting system for monitoring an amount of the therapeutic radiation generated by said target element, said radiation detecting system including:

a. a scintillator disposed along a path of a portion of the therapeutic radiation emitted by said target element and adapted to generate scintillator light in

response to the therapeutic radiation incident thereon, wherein the intensity of said scintillator light is proportional to the intensity of said incident therapeutic radiation;

b. a photodetector in optical communication with said scintillator for converting said scintillator light into a signal indicative of the intensity of the therapeutic radiation that is incident on said scintillator.

25. A therapeutic radiation source according to claim 1, wherein said radiation generator assembly further comprises a substantially rigid capsule enclosing said electron source and said target element and defining a substantially evacuated interior region extending along a beam axis, said capsule including a radiation transmissive window, wherein the therapeutic radiation emitted from said target element is directed through the radiation transmissive window.

26. A therapeutic radiation source according to claim 1,
wherein said means for providing an accelerating voltage comprises a high voltage power supply.

27. A therapeutic radiation source according to claim 24, wherein said electron emissive surface of said thermionic cathode is formed of a metallic material.

28. A therapeutic radiation source according to claim 27, wherein said metallic material comprises tungsten, thoriated tungsten, tungsten alloys, and tantalum.

29. A therapeutic radiation source according to claim 24, wherein the thermionic cathode

comprises a metallic base coated with an oxide.

30. A therapeutic radiation source according to claim 29, wherein said oxide comprises barium oxide, strontium oxide, and calcium oxide, and said metallic base comprises nickel.

31. A therapeutic radiation source, comprising:

A. a flexible fiber optical cable assembly, said fiber optical cable assembly including a first optical fiber, said first optical fiber having a proximal end and a distal end, said first optical fiber being adapted for transmitting optical radiation incident on said proximal end to said distal end;

B. an optical source, including means for generating a beam of optical radiation directed to said proximal end of said first optical fiber;

C. a radiation generator assembly coupled to said distal end of said first optical fiber, including:

    a. an electron source for emitting electrons in response to optical radiation transmitted to said distal end; and

    b. a target element, including at least one radiation emissive material adapted to generate therapeutic radiation in response to incident electrons from said electron source;

D. means for providing an accelerating voltage between said electron source and said target element so as to establish an accelerating electric field which acts to accelerate electrons emitted from said electron source toward said target element; and

E. an in situ radiation detecting system for monitoring an amount of the therapeutic radiation generated by said target element, said radiation detecting system including:

a. a second optical fiber, said second optical fiber being formed of a scintillating material, said second optical fiber being disposed outside said radiation generator assembly and said fiber optical cable assembly and along a path of the therapeutic radiation generated by said target element, said second optical fiber being adapted to emit light in response to incident therapeutic radiation generated by said target element;

b. a photodetector in optical communication with said second optical fiber for providing a signal indicative of the amount of therapeutic radiation that is incident on said second optical fiber; and

c. a feedback controller responsive to said indicative signal for calculating a cumulative dosage of said emitted therapeutic radiation and for controlling the intensity and duration of said therapeutic radiation.

32. A therapeutic radiation source, comprising:

A. a flexible fiber optical cable assembly, said fiber optical cable assembly including a first optical fiber having a proximal end and a distal end, said first optical fiber being adapted for transmitting optical radiation incident on said proximal end to said distal end;

B. an optical source, including means for generating a beam of optical radiation directed to said proximal end of said first optical fiber;

C. a radiation generator assembly coupled to said distal end of said first optical fiber, including:

a. an electron source for emitting electrons in response to optical radiation transmitted to said distal end; and

b. a target element, including at least one radiation emissive element adapted to generate therapeutic radiation in response to incident electrons from said electron source; and

D. means for providing an accelerating voltage between said electron source and said target element so as to establish an accelerating electric field which acts to accelerate electrons emitted from said electron source toward said target element; and

E. an in situ radiation detecting system for monitoring an amount of the therapeutic radiation emitted by said target element, said radiation detecting system including:

a. a second optical fiber, said second optical fiber being formed of a scintillation material and adapted to emit light in response to incident therapeutic radiation, wherein said second optical fiber is attached to said first optical fiber and is positioned along a path of the therapeutic radiation emitted by said target element;

b. a photodetector in optical communication with said second optical fiber for providing a signal indicative of the amount of the emitted therapeutic radiation that is incident on said second optical fiber; and

c. a feedback controller responsive to said indicative signal for calculating a cumulative dosage of said emitted therapeutic radiation and for controlling the intensity and duration of said therapeutic radiation.

33. A therapeutic radiation source according to claim 1, wherein said optical source is selected from the group consisting of a Nd:YAG laser, a diode laser, and a $Nd:YVO_4$ laser.

34. A therapeutic radiation source according to claim 8, wherein said optical system includes $Nd:YVO_4$ absorber material.

35. A therapeutic radiation source, comprising:

A. a probe assembly including a fiber optic cable having a proximal end and a distal end, said fiber optic cable being adapted for transmitting optical radiation incident on said proximal end to said distal end;

B. an optical source, including means for generating a beam of optical radiation directed to said proximal end of said optical delivery structure;

C. a radiation generator assembly coupled to the probe assembly, including:

   a. an electron source, responsive to optical radiation transmitted to said distal end of said optical delivery structure, for emitting electrons to generate an electron beam along a beam path; and

   b. a target element positioned in said beam path, said target element including at least one radiation emissive material adapted to emit therapeutic radiation in response to incident electrons from said electron beam;

D. means for providing an accelerating voltage between said electron source and said target element so as to establish an accelerating electric field which acts to accelerate electrons emitted from said electron source toward said target element; and

E. a photodetector in optical communication with said fiber optic cable;

wherein said fiber optic cable is formed of a scintillating material and disposed along a path of a portion of the therapeutic radiation emitted by said target element;

wherein said fiber optic cable being adapted to generate scintillator light in response to therapeutic radiation incident thereon, the intensity of said scintillator light being proportional to the intensity of said incident therapeutic radiation; and

wherein said photodetector is adapted to convert said scintillator light into a signal indicative of the intensity of said incident therapeutic radiation.

36. A therapeutic radiation source according to claim 3, wherein said display unit is operable to display a plurality of colors that represent a corresponding plurality of radiation doses delivered to said treatment region.

37. A therapeutic radiation source according to claim 1, wherein said optical source is a LED (light emitting diode).